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ORBIT OF THE SPECTROSCOPIC BINARY 40 AURIGÆ

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Forty Aurigæ ($\alpha = 5^{\text{h}} 59^{\text{m}}.6$, $\delta = +38^\circ 29'$, mag. 5.31, type A) was announced as a spectroscopic binary by Lee in the *Astrophysical Journal*, Vol. XXXIX, 1914. The following discussion of the orbit is based on measures of the three plates given there, and fifty-three taken here with a one-prism spectrograph attached to the 15-inch telescope.

TABLE I

λ	λ	λ	λ
4005.402	4202.118	4294.270	4481.462
4030.766	4215.744	4307.979	4501.503
4033.092	4233.421	4325.907	4508.455
4045.974	4236.001	4340.669	4520.430
4063.706	4250.698	4351.990	4522.909
4071.862	4260.579	4395.287	4534.140
4101.891	4271.643	4404.928	4549.747
4143.789	4282.585	4415.213	4558.990
4191.672	4290.119	4468.870	4572.143
4198.719	4077.885		

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Table I gives the wave-lengths of the lines used in reducing the measures. They are the same as those found for the binary Groombridge 1149 and seem to suit the present spectrum very well. The journal of observations follows in Table II. The residuals given in this table under O-C were determined graphically from the final curve. The weights are those used in the least-square solution.

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TABLE II

Plate	Observer*	Date	Julian Day	Phase from 2,420,462	Primary			Secondary		
					Velocity	Weight	O-C	Velocity	Weight	O-C
Yerkes		1913, Oct. 2	2,420,043.924	6.124	-58.5	.....	+ 4	+130.8	.....	+16
"		" 3	44.892	7.092	-35.6	.....	+13	+ 92.9	.....	+ 3
"		" 6	47.897	10.097	+22.8	.....	.....	.....	.....	.....
6601	Y	1914, Dec. 5	2,420,472.855	10.855	+19.1	.....	.....	.....	.....	.....
6606	H	" 6	473.753	11.753	+17.9	.....	.....	.....	.....	.....
6610	Y	" 20	477.908	15.908	+21.0	.....	.....	.....	.....	.....
6629	Y-H	" 15	482.727	20.727	+21.0	.....	.....	.....	.....	.....
6645	Y	" 17	484.823	22.823	+20.2	.....	.....	.....	.....	.....
6657	C	" 23	490.632	0.352	+21.1	.....	.....	.....	.....	.....
6661	Y	" 25	492.663	2.383	+18.0	.....	.....	.....	.....	.....
6668	Y	" 30	497.622	7.352	-42.2	1	0	+ 91.1	1	+ 3
6673	Y	" 31	498.719	8.439	+ 5.4	.....	.....	.....	.....	.....
6704	Y	1915, Jan. 10	508.688	18.408	+20.4	.....	.....	.....	.....	.....
6727	Y	" 23	521.802	3.242	+12.4	.....	.....	.....	.....	.....
6732	Y	" 24	522.664	4.104	- 9.5	1	+ 5	+ 72.3	1	+15
6745	P ¹	" 27	525.755	7.195	-48.1	1	- 2	+ 92.4	1	- 1
6751	Y	" 28	526.775	8.215	+ 3.2	.....	.....	.....	.....	.....
6762	P	" 30	528.678	10.118	+15.2	.....	.....	.....	.....	.....
6768	C-P ¹	Feb. 3	532.710	14.150	+25.2	.....	.....	.....	.....	.....
6806	C	" 19	548.567	1.727	+18.0	.....	.....	.....	.....	.....
6811	P	" 20	549.711	2.871	+12.8	.....	.....	.....	.....	.....
6814	Y	" 21	550.597	3.757	+ 0.4	.....	.....	.....	.....	.....
6884	H	Mar. 22	579.618	4.498	-24.8	1	0	+ 75.4	1	+ 7
6887	Y	" 23	580.563	5.443	-51.2	1	+ 1	+ 91.1	1	- 9
6938	Y	April 20	608.549	5.149	-42.5	1	+ 2	+ 89.4	1	0
6946	C	" 21	609.594	6.194	-67.8	1	- 5	+108.0	1	- 6
7226	Y	Sept. 9	750.864	6.064	-66.4	1	- 3	+109.7	1	- 4
7324	Y	Oct. 9	780.872	7.792	-26.3	1	+ 4	+ 80.2	1	+ 6
7330	H	" 10	781.731	8.651	+ 6.7	.....	.....	.....	.....	.....
7336	C	" 11	782.832	9.752	+13.6	.....	.....	.....	.....	.....
7374	Y-C	Nov. 3	805.747	4.387	-23.7	1	- 4	+ 59.9	1	- 4
7383	Y	" 6	808.804	7.444	-43.4	1	- 3	+ 85.1	1	- 1
7438	Y	Dec. 2	834.919	5.279	-48.6	1	- 1	+ 93.6	1	- 1
7439	Y	" 2	834.957	5.317	-54.7	1	- 6	+100.2	1	+ 4
7441	Y	" 3	835.625	5.985	-64.6	1	- 3	+116.2	1	+ 2
7444	C	" 3	835.814	6.174	-67.2	1	- 4	+108.6	1	- 5
7466	H	" 30	862.637	4.717	-33.2	1	- 2	+ 71.1	1	- 4
7467	H-Y	" 30	862.695	4.775	-27.2	1	+ 5	+ 72.5	1	- 4
7497	C	1916, Jan. 28	891.729	5.529	-49.3	1	+ 1	+ 95.7	1	- 8
7498	C	" 28	891.776	5.576	-54.2	1	+ 2	+ 77.0	1	+11
7524	C	Feb. 28	922.566	8.086	-20.8	1	+ 1	+ 64.4	1	- 3
7525	C	" 28	922.622	8.142	-23.2	1	+ 1	+ 63.7	1	- 4
7526	C	" 28	922.678	8.198	-23.3	1	+ 1	+115.2	1	+ 6
7576	Y-P	Mar. 25	948.520	5.760	-56.0	1	+ 3	+ 70.3	1	- 7
7787	Y	Aug. 15	2,421,091.853	7.693	-34.5	1	0	+ 115.4	1	+ 4
7810	Y	Sept. 11	118.849	6.409	-55.6	1	+ 6	+ 117.0	1	+ 6
7811	Y	" 11	118.896	6.456	-57.6	1	+ 4	+ 58.6	1	-10
7873	Y	Oct. 11	148.741	8.021	-25.4	1	- 1	+121.2	1	+10
7924	Y	Dec. 5	203.670	6.390	-63.8	1	- 1	+ 91.0	1	-10
8074	Y	1917, Feb. 27	287.553	5.453	-50.9	1	+ 2	+ 84.8	1	- 3
8081	Y	Mar. 1	288.497	7.397	-42.0	1	- 1	+ 84.8	1	+ 4
8083	Y	" 1	288.615	7.515	-43.7	1	- 5	+ 87.2	1	+ 4
8084	Y	" 1	288.679	7.579	-39.3	1	- 1	+ 82.6	1	+ 2

*P=Plaskett; H=Harper; C=Cannon; P¹=Parker; Y=Young

MEASURES OF 40 AURIGÆ

N	6601		6606		6610		6629		6645		6657		6661	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005			+17.9	1	+18.9	1	+25.6	1	+20.4	1	+20.4	1	+25.8	1
4024					+20.5	1					+21.6	1		
4030	+14.9	1			+15.1	1	+22.2	1	+11.5	1	+19.5	1	+16.0	1
4045	+5.3	1	+5.3	1			+8.2	1	+11.8	1	+21.7	1	+19.9	1
4063	+14.5	1	+18.1	1										
4071					+10.2	1			+15.5	1	+22.8	1	+15.5	1
4077	+3.8	1	+11.9	1	+13.7	1					+16.7	1		
4143	+8.1	1	+11.0	1							+27.4	1	+23.3	1
4202							+12.2	1	+32.7	1	+16.3	1	+26.7	1
4215	+11.2	1	+14.3	1							+19.4	1	+19.9	1
4233	+12.1	1			+16.3	1					+16.3	1	+4.8	1
4250											+30.3	1	+21.2	1
4260	+11.6	1	+3.1	1			+23.1	1	+23.1	1			+16.1	1
4271	+13.5	1	+3.8	1									+25.8	1
4282					+14.2	1	+4.1	1	+14.2	1	+27.9	1	+22.8	1
4289	+7.6	1	-0.2	1							+25.1	1		
4294							+17.8	1					+17.8	1
4325	+4.4	1									+28.1	1		
4340					+27.0	1					+22.8	1	+13.6	1
4352	+5.6	1	+13.7	1										
4404	+13.0	1												
4415	+18.9	1												
4468											+25.8	1		
4481	+17.1	1	+23.3	1	+10.2	1	+25.8	1			+28.1	1	+23.8	1
4501	+21.7	1									+12.8	1	+28.4	1
4508	+12.8	1												
4522	+0.2	1	+9.2	1										
4534														
4549	+2.6	1	+3.9	1	+13.0	1	+24.9	1			+19.7	1	+18.3	1
4572	+26.6	1	+11.9	1										
Weighted mean	+ 11.35		+ 10.50		+ 15.75		+ 18.21		+ 18.46		+ 21.98		+ 19.98	
V _a	+ 8.20		+ 7.76		+ 5.71		+ 3.27		+ 2.22		- 0.74		- 1.79	
V _d	- 0.15		- 0.12		- 0.21		- 0.18		- 0.15		+ 0.11		+ 0.07	
Curv.	- 0.28		- 0.28		- 0.28		- 0.28		- 0.28		- 0.28		- 0.28	
Radial Velocity	+ 19.1		+ 17.9		+ 21.0		+ 21.0		+ 20.2		+ 21.1		+ 18.0	

MEASURES OF 40 AURIGÆ—Continued

λ	6668				6673		6704		6727		6732			
	Primary		Secondary								Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	-42.0	1	+99.1	1			+46.9	1	+35.8	1	+7.2	1	+78.7	1
4030	-34.6	1	+97.6	1	+5.3	1	+28.4	1	+21.7	1	-0.8	1	+68.6	1
4045	-46.8	1	+80.3	1										
4063	-38.9	1	+98.3	1	+0.9	1	+26.5	1	+21.9	1	+14.6	1		
4071	-37.4	1	+89.5	1							-6.8	1	+95.4	1
4077	-30.6	1	+98.0	1										
4143														
4198	-42.4	1			+16.7	1			+36.5	1				
4202					+15.3	1	+26.6	1	+28.7	1				
4215							+26.4	1	+24.8	1	+3.2	1	+77.6	1
4250											+13.0	1	+115.3	1
4260														
4271	-34.8	1	+99.3	1			+26.9	1	+26.3	1				
4289	-34.8	1	+96.7	1			+38.1	1	+29.4	1	+19.1	1	+97.4	1
4308	-31.6	1			+5.5	1			+22.3	1				
4325									+22.5	1				
4340							+31.9	1	+45.6	1				
4352					+28.4	1	+38.4	1	+28.4	1				
4481							+23.0	1						
4501							+32.4	1						
4522					+11.7	1	+28.6	1	+28.6	1				
4534							+26.2	1						
4549	-45.9	1	+97.1	1	+15.7	1			+32.0	1				
4572														
Weighted mean	-37.66		+95.61		+10.57		+30.49		+28.71		+7.05		+88.83	
V _a	-4.32		-4.32		-4.82		-9.80		-15.79		-16.16		-16.16	
V _d	+0.10		+0.10		-0.06		-0.08		-0.21		-0.07		-0.07	
Curv.	-0.28		-0.28		-0.28		-0.28		-0.28		-0.28		-0.28	
Radial Velocity	-42.2		+91.1		+5.4		+20.4		+12.4		-9.5		+72.3	

MEASURES OF 40 AURIGÆ—Continued

λ	6745				6751		6762		6768		6806		6811			
	Primary		Secondary		Vel.	Wt.										
	Vel.	Wt.	Vel.	Wt.												
4005	-30.9	1					-30.7	1	+55.5	1	+56.3	1	+48.7	1		
							-33.2	1			+49.0	1				
4045	-34.6	1					-31.0	1	+40.8	1	+41.2	1	+33.3	1		
4063	-28.8	1					-32.6	1			+40.7	1				
4077	-20.1	1	+94.0	1	+10.0	1	-34.7	1			+39.3	1	+43.8	1		
4143	-27.7	1	+116.4	1			-33.2	1	+51.6	1	+43.8	1	+40.0	1		
							+20.4	1			+34.4	1	+37.5	1		
4198									-51.7	1			+46.1	1		
4202									-36.8	1	+50.8	1		+50.2	1	
4215	-33.6	1	+123.0	1			+10.1	1			+39.7	1				
4233									-23.7	1	+34.2	1	+49.1	1	+28.5	1
4250									-29.7	1						
4260									-33.9	1			+39.2	1	+29.6	1
4271	-40.2	1	+103.6	1					-34.9	1	+55.3	1	+41.3	1	+31.6	1
4289									-38.9	1						
4308									-13.4	1						
4325									+28.2	1	-48.7	1		+42.8	1	
4340														+40.1	1	
4395														+56.6	1	
4481									+25.8	1	-34.6	1				
4501									+16.6	1						
4522	-30.7	1	+117.4	1			+36.0	1			-28.6	1		+30.5	1	
4534											-24.9	1		+43.3	1	
4549									+26.2	1	-45.3	1		+37.3	1	
4572														+49.3	1	
Weighted mean	-30.20		+110.30		+21.50		+34.16		+45.76		+43.31		+38.60			
V_a	-17.44		-17.44		-17.85		-18.59		-20.12		-25.03		-25.32			
V_d	-0.19		-0.19		-0.21		-0.10		-0.18		-0.03		-0.21			
Curv.	-0.28		-0.28		-0.28		-0.28		-0.28		-0.28		-0.28			
Radial Velocity	-48.1		+92.4		+3.2		+15.2		+25.2		+18.0		+12.8			

MEASURES OF 40 AURIGÆ—Continued

λ	6814		6884				6887				6938			
			Primary		Secondary		Primary		Secondary		Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005							-23·8	1	+125·6	1	-16·1	1	+107·6	1
4030			+ 9·2	1			-20·4	1			-20·1	1		
4045	+22·2	1	+ 1·7	1							-15·1	1		
4063	+11·8	1	- 3·5	1							-16·4	1	+120·5	1
4077	+27·4	1	+14·6	1	+125·1	1	-21·9	1	+107·7	1	-15·1	1		
4143	+29·3	1	+10·5	1			-18·0	1	+139·6	1	-19·0	1	+116·4	1
4215			+ 9·2	1	+ 99·4	1	-19·1	1	+122·0	1	-23·5	1	+ 98·8	1
4260			- 7·5	1	+103·0	1	-36·2	1	+ 92·4	1				
4271							-16·6	1	+124·0	1				
4289	+39·0	1					-17·0	1	+122·4	1	-19·7	1	+124·5	1
4325			- 6·7	1	+ 90·3	1	-21·1	1			-11·4	1		
4340	+32·6	1					-23·9	1	+133·2	1				
4415							-18·0	1	+128·3	1				
4522							-30·2	1	+115·8	1				
4549	+22·3	1												
Weighted mean	+ 26·37		+ 4·13		+104·45		- 21·95		+120·37		- 16·92		+114·97	
V _a	- 25·53		- 28·50		- 28·50		- 28·84		- 28·84		- 25·05		- 25·05	
V _d	- 0·10		- 0·20		- 0·20		- 0·15		- 0·15		- 0·21		- 0·21	
Curv.	- 0·28		- 0·28		- 0·28		- 0·28		- 0·28		- 0·28		- 0·28	
Radial Velocity	+ 0·4		- 24·8		+ 75·4		- 51·2		+ 91·1		- 42·5		+ 89·4	

MEASURES OF 40 AURIGÆ—Continued

X	6946				7226				7324				7330	
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	-59.1	1	+116.5	1	-100.7	1	.....	.....	-51.7	1	.....	.....	-20.0	1
4045	-49.7	1	+148.1	1	-113.9	1	.....	.....	-53.2	1	+43.0	1	-21.0	1
4063	.....	.....	.....	.....	-110.7	1	.....	.....	-52.8	1	.....	.....	-17.9	1
4071	.....	.....	.....	.....	.....	.....	.....	.....	-60.8	1	.....	.....	-21.0	1
4077	-42.9	1	+131.5	1	-81.7	1	+75.4	1	-47.5	1	+61.8	1	-18.8	1
4143	-31.1	1	+129.4	1	-88.5	1	+83.7	1	-48.8	1	.....	.....	-11.2	1
4198	-44.4	1	.....	.....	.....	.....	.....	.....	-51.8	1	+56.4	1	-23.1	1
4215	-32.9	1	.....	.....	-97.0	1	.....	.....	-65.9	1	.....	.....	-23.0	1
4236	-40.5	1	.....	.....	.....	.....	.....	.....	-51.0	1	.....	.....	-27.2	1
4260	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4271	.....	.....	.....	.....	-87.0	1	.....	.....	-53.5	1	+46.3	1	.....	.....
4289	-55.1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4308	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4340	-58.3	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4404	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4415	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4481	-39.2	1	+141.0	1	-86.0	1	+84.8	1	.....	.....	.....	.....	.....	.....
4549	.....	.....	.....	.....	-92.8	1	.....	.....	.....	.....	.....	.....	-18.0	1
4572	-32.8	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Weighted mean	-42.46	1	+133.30	1	-94.16	1	+81.90	1	-53.70	1	+52.85	1	-20.67	1
V _a	-24.79	1	-24.79	1	+27.85	1	+27.85	1	+27.50	1	+27.50	1	+27.45	1
V _d	-0.23	1	-0.23	1	+0.22	1	+0.22	1	+0.07	1	+0.07	1	+0.21	1
Curv.	-0.28	1	-0.28	1	-0.28	1	-0.28	1	-0.28	1	-0.28	1	-0.28	1
Radial Velocity	-67.8	1	+108.0	1	-66.4	1	+109.7	1	-26.3	1	+80.2	1	+6.7	1

MEASURES OF 40 AURIGÆ—Continued

λ	7336		7374				7383				7438			
			Primary		Secondary		Primary		Secondary		Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005							-62.0	1	+47.9	1	-51.3	1		
4033	-	8.0	-45.8	1	+44.0	1	-59.9	1			-53.2	1	+71.0	1
4045	-	8.0	-39.5	1	+46.1	1	-61.3	1	+63.4	1	-58.6	1	+76.2	1
4063	-	10.8	-		+49.6	1	-		-		-		+88.1	1
4071	-		-		-		-		-		-		-	
4077	-	10.9	-		-		-57.5	1	+78.5	1	-42.0	1	+75.8	1
4143	-		-		+53.7	1	-64.3	1	+52.2	1	-		-	
4191	-		-45.0	1	+32.0	1	-69.0	1	-		-62.0	1	+82.0	1
4198	-	13.1	-		-		-72.9	1	-		-		-	
4215	-	17.9	-49.8	1	-		-58.5	1	+66.2	1	-56.3	1	+77.6	1
4233	-		-		-		-		-		-52.0	1	-	
4236	-	13.6	-		-		-68.0	1	+55.3	1	-73.8	1	-	
4260	-	19.1	-		-		-		+81.5	1	-61.2	1	-	
4271	-	18.8	-		-		-62.6	1	+59.3	1	-70.2	1	-	
4289	-	10.9	-		-		-		-		-59.0	1	-	
4308	-		-		-		-		+78.0	1	-61.1	1	+83.7	1
4340	-		-		-		-		-		-52.5	1	+108.0	1
4352	-		-		-		-		-		-48.8	1	+97.6	1
4481	-		-48.5	1	+18.7	1	-		-		-		-	
4534	-	9.7	-		-		-65.6	1	-		-64.3	1	-	
4549	-	15.7	-		-		-		-		-		-	
Weighted mean	-	13.50	-45.27	-	+38.35	-	63.78	-	+64.70	-	57.76	-	+84.44	-
V_a	+	27.29	+	21.67	+	21.67	+	20.64	+	20.64	+	9.67	+	9.67
V_d	+	0.11	+	0.13	+	0.13	+	0.05	+	0.05	-	0.20	-	0.20
Curv.	-	0.28	-	0.28	-	0.28	-	0.28	-	0.28	-	0.28	-	0.28
Radial Velocity	+	13.6	-	23.7	+	59.9	-	43.4	+	85.1	-	48.6	+	93.6

MEASURES OF 40 AURIGÆ—Continued

λ	7439				7441				7444					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	.....	.....	.....	.....	-68.0	½	+113.3	½	.....	.....	.....	.....	.....	.....
4033	-59.6	½	.....	.....	-64.1	½	.....	.....	-75.0	½	.....	.....	.....	.....
4045	-71.8	½	.....	.....	-72.7	½	+115.6	½	.....	.....	.....	.....	.....	.....
4071	-45.4	½	+100.8	½	.....	.....	-80.0	½	+ 94.4	½	-69.6	½	+ 96.3	½
4077	.....	.....	.....	.....	.....	.....	-76.4	½	+108.8	½	-66.7	½	+102.5	½
4143	.....	.....	.....	.....	.....	.....	.....	.....	-64.1	½	.....	.....	.....	.....
4215	-64.1	½	+ 91.8	½	.....	.....	-73.8	½	+117.5	½	.....	.....	+104.5	½
4236	-77.0	.....	.....	.....	.....	.....	.....	.....	+ 96.0	½	.....	.....	.....	.....
4250	-73.8	½	+ 79.1	½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4260	-82.9	½	.....	.....	.....	.....	-75.1	½	+100.1	½	-71.3	½	+ 90.0	½
4289	-66.4	½	.....	.....	.....	.....	-75.6	½	.....	.....	-84.4	½	+ 93.8	½
4308	-49.6	½	.....	.....	.....	.....	-80.5	½	.....	.....	.....	.....	.....	.....
4325	.....	.....	.....	.....	.....	.....	-56.0	½	.....	.....	.....	.....	.....	.....
4340	.....	.....	.....	.....	.....	.....	-84.4	½	+106.1	½	.....	.....	.....	.....
4352	.....	.....	.....	.....	.....	.....	-76.0	½	+111.3	½	-93.9	½	+111.4	½
4395	.....	.....	.....	.....	.....	.....	-82.1	½	+107.6	½	-84.0	½	.....	.....
4481	-40.0	½	+ 95.0	½	.....	.....	-68.2	½	.....	.....	.....	.....	.....	.....
4549	-72.2	½	+ 78.7	½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Weighted mean	- 63.89	.....	+ 91.08	.....	- 73.78	.....	+107.07	.....	- 76.12	.....	+ 99.75	.....	.....	.....
V_a	+ 9.65	.....	+ 9.65	.....	+ 9.33	.....	+ 9.33	.....	+ 9.24	.....	+ 9.24	.....	.....	.....
V_d	- 0.22	.....	- 0.22	.....	+ 0.12	.....	+ 0.12	.....	- 0.08	.....	- 0.08	.....	.....	.....
Curv.	- 0.28	.....	- 0.28	.....	- 0.28	.....	- 0.28	.....	- 0.28	.....	- 0.28	.....	.....	.....
Radial Velocity	- 54.7	.....	+100.2	.....	- 64.6	.....	+116.2	.....	- 67.2	.....	+108.6	.....	.....	.....

MEASURES OF 40 AURIGÆ—Continued

λ	7466				7467				7497				Vel.	Wt.		
	Primary		Secondary		Primary		Secondary		Primary		Secondary					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.				
4005	-19.7	½	+63.7	½	-20.0	½	+72.5	½	-26.5	½	+129.1	½	.....	.....
4030	.....	.....	.....	.....	-20.5	½	.....	.....	-34.1	½	.....	.....	.....	.....
4033	.....	.....	.....	.....	.....	.....	.....	.....	-42.4	½	.....	.....	.....	.....
4045	-26.2	½	+70.1	½	.....	.....	.....	.....	-35.0	½	.....	.....	.....	.....
4063	-18.9	½	+81.6	½	-23.0	½	+72.2	½	.....	.....	+105.5	½	.....	.....
4071	-26.8	½	.....	.....	.....	.....	.....	.....	.....	.....	+99.9	½	.....	.....
4077	-32.5	½	+83.1	½	.....	.....	.....	.....	-28.3	½	+121.4	½	.....	.....
4101	.....	.....	.....	.....	.....	.....	.....	.....	-15.9	½	.....	.....	.....	.....
4143	-17.9	½	.....	.....	-29.0	½	+67.7	½	-21.3	½	+123.8	½	.....	.....
4191	-36.0	½	.....	.....	-14.0	½	+72.0	½	-30.0	½	.....	.....	.....	.....
4205	.....	.....	.....	.....	-36.6	½	.....	.....	.....	.....	.....	.....	.....	.....
4215	-25.1	½	+92.3	½	.....	.....	.....	.....	-26.7	½	+108.8	½	.....	.....
4233	.....	.....	.....	.....	-25.4	½	.....	.....	.....	.....	+134.8	½	.....	.....
4236	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4250	-20.6	½	+67.0	½	-9.5	½	+91.8	½	-35.3	½	+111.3	½	.....	.....
4260	-34.5	½	+74.4	½	.....	.....	-79.7	½	.....	.....	+109.5	½	.....	.....
4271	-49.3	½	+71.8	½	-26.8	½	+83.7	½	-29.5	½	+97.1	½	.....	.....
4290	-37.0	½	.....	.....	.....	.....	.....	.....	-32.1	½	+119.7	½	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+99.8	½	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	-33.5	½	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	-35.6	½	+135.2	½	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	-37.5	½	+158.3	½	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	-34.1	½	+116.8	½	.....	.....
Weighted mean	-28.74	+	75.50	—	22.75	+	77.10	—	31.11	+	117.40	—	.....	.....
V _a	-4.27	—	4.27	—	4.30	—	4.30	—	17.72	—	17.72	—	.....	.....
V _d	+0.08	+	0.08	—	0.02	—	0.02	—	0.18	—	0.18	—	.....	.....
Curv.	-0.28	—	0.28	—	0.28	—	0.28	—	0.28	—	0.28	—	.....	.....
Radial Velocity	-33.2	+	71.1	—	27.2	+	72.5	—	49.3	+	99.2	—	.....	.....

MEASURES OF 40 AURIGÆ—Continued

λ	7498				7524				7525					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.		
4005	-32.9	1	.....	.....	-4.3	1	+108.6	1	+0.4	1	+91.3	1	
4030	.....	.....	.....	.....	+15.8	1	+85.8	1	+6.8	1	+90.7	1	
4033	.....	.....	.....	.....	-6.1	1	.....	.....	.....	.....	.....	.....
4045	-43.9	1	.....	.....	.....	.....	.....	.....	+9.3	1	+93.1	1	
4063	-39.7	1	.....	.....	+9.0	1	+95.7	1	0.0	1	.....	.....
4071	.....	.....	.....	.....	+13.6	1	.....	.....	+8.2	1	.....	.....
4077	-36.5	1	+115.0	1	+3.7	1	.....	.....	.....	.....	.....	.....
4143	-21.3	1	+120.8	1	.....	.....	.....	.....	+6.8	1	.....	.....
4191	-33.5	1	+113.0	1	.....	.....	.....	.....	+11.3	1	.....	.....
4215	-37.1	1	+118.0	1	+6.1	1	.....	.....	+7.1	1	.....	.....
4260	-37.2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4271	-40.8	1	+105.2	1	+14.0	1	+126.9	1	.....	.....	.....	.....
4290	-30.5	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4307	-39.2	1	+105.9	1	.....	.....	.....	.....	-0.6	1	.....	.....
4340	-39.1	1	+102.2	1	.....	.....	.....	.....	-6.8	1	.....	.....
4351	.....	.....	+131.1	1	.....	.....	.....	.....	.....	.....	.....	.....
Weighted mean	-35.97	1	+113.90	1	+6.47	1	+104.25	1	+4.15	1	+92.00	1		
V_a	-17.74	1	-17.74	1	-26.93	1	-26.93	1	-26.94	1	-26.94	1		
V_d	-0.21	1	-0.21	1	-0.07	1	-0.07	1	-0.14	1	-0.14	1		
Curv.	-0.28	1	-0.28	1	-0.28	1	-0.28	1	-0.28	1	-0.28	1		
Radial Velocity	-54.2	1	+95.7	1	-20.8	1	+77.0	1	-23.2	1	+64.4	1		

MEASURES OF 40 AURIGE—Continued

No.	7526				7570				7687			
	Primary		Secondary		Primary		Secondary		Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
1405					-32.5 ¹	¹	+143.6 ¹	¹	-63.9 ¹	¹		
1430					-30.6 ¹	¹						
1433					-32.9 ¹	¹						
1445	+ 0.9 ¹	¹	+ 81.6 ¹	¹	-28.8 ¹	¹	+160.1 ¹	¹	-74.6 ¹	¹	+47.2 ¹	¹
1463	+ 5.4 ¹	¹	+ 84.3 ¹	¹	-34.7 ¹	¹	+108.2 ¹	¹	-50.3 ¹	¹	+52.1 ¹	¹
1477	+ 7.3 ¹	¹			-32.9 ¹	¹	+121.4 ¹	¹				
1483					-19.3 ¹	¹	+149.4 ¹	¹	-50.6 ¹	¹		
1491					-21.5 ¹	¹						
1492									-67.1 ¹	¹	+48.5 ¹	¹
1495					26.7 ¹	¹						
1499					-22.9 ¹	¹			-49.1 ¹	¹		
1500	+ 1.1 ¹	¹			-29.8 ¹	¹			-55.0 ¹	¹	+53.9 ¹	¹
1471					-17.2 ¹	¹						
1489					-27.2 ¹	¹			-79.3 ¹	¹		
1498					-23.7 ¹	¹						
1525	0.0 ¹	¹	+ 85.0 ¹	¹								
1540	+19.8 ¹	¹	+109.0 ¹	¹	-33.7 ¹	¹	+159.7 ¹	¹	-31.6 ¹	¹		
1552	+ 5.7 ¹	¹	+ 95.8 ¹	¹			+161.3 ¹	¹				
1481					-18.2 ¹	¹			-70.3 ¹	¹	+35.8 ¹	¹
1501									-34.1 ¹	¹		
1515									-66.4 ¹	¹		
1534									-41.4 ¹	¹		
1549					-24.9 ¹	¹	+150.9 ¹	¹	-69.3 ¹	¹		
Weighted mean	+ 4.11		+ 91.11		- 26.91		+144.32		- 57.36		+ 47.50	
V _r	- 26.95		- 26.73		- 28.73		- 28.73		+ 22.86		+ 22.86	
V _t	+ 0.20		+ 0.20		+ 0.10		+ 0.10		+ 0.24		+ 0.24	
Curv	+ 0.28		+ 0.28		+ 0.28		+ 0.28		+ 0.28		+ 0.28	
Radial Velocity	- 23.3		+ 63.7		- 56.0		+115.2		- 34.5		+ 70.3	

MEASURES OF 40 AURIGÆ—Continued

λ	7810				7811				7873			
	Primary		Secondary		Primary		Secondary		Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4045					- 82.1	1	+ 113.4	1	- 58.3	1	+ 28.3	1
4063	- 89.6	1	+ 69.2	1					- 54.9	1	+ 28.1	1
4071												
4143			+ 83.6	1	- 71.8	1	+ 91.3	1				
4198	- 82.0	1										
4215					- 78.7	1	+ 70.3	1				
4233	- 86.4	1										
4236	- 88.6	1	+ 81.9	1	- 100.8	1						
4250					- 83.6	1			- 54.5	1	+ 40.7	1
4260	- 78.3	1	+ 88.6	1	- 90.2	1			- 36.8	1		
4271	- 80.5	1			- 92.3	1	+ 87.8	1	- 51.3	1	+ 45.4	1
4289	- 98.7	1	+ 96.2	1	- 88.0	1						
4325					- 88.0	1	+ 73.1	1				
4340					- 76.6	1	+ 60.6	1				
4351			+ 92.5	1			+ 79.5	1				
4395												
4481	- 70.3	1	+ 103.7	1	- 97.4	1	+ 104.3	1	- 59.1	1	+ 15.1	1
4501	- 81.4	1	+ 76.7									
4549	- 86.3	1	+ 87.5	1	- 75.8	1	+ 96.8	1				
4572	- 77.6	1										
Weighted mean	- 83.61	1	+ 87.30		- 85.61	1	+ 88.93		- 52.48	1	+ 31.52	
V_s	+ 28.13	1	+ 28.13		+ 28.20	1	+ 28.20		+ 27.18	1	+ 27.18	
V_d	+ 0.20	1	+ 0.20		+ 0.13	1	+ 0.13		+ 0.21	1	+ 0.21	
Curv.	- 0.28	1	- 0.28		- 0.28	1	- 0.28		- 0.28	1	- 0.28	
Radial Velocity	- 55.6	1	+ 115.4		- 57.6	1	+ 117.0		- 25.4	1	+ 58.6	

MEASURES OF 40 AURIGE - *Continued*

No.	7924				8074				8081			
	Primary		Secondary		Primary		Secondary		Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	-73.0	1			-22.2	1	+113.2	1	-14.1	1	+113.2	1
4030	-61.4	1			-26.2	1						
4033			+121.6	1	-29.4	1						
4045	-71.8	1	+126.8	1	-27.5	1	+116.2	1	-16.8	1	+125.5	1
4063	-73.9	1			-21.7	1	+105.5	1				
4071					-13.6	1	+118.5	1	-8.6	1	+129.5	1
4077	-73.0	1			-23.7	1	+115.5	1	-1.6	1	+112.2	1
4143	-66.7	1	+105.9	1	-17.9	1	+127.6	1				
4198	-75.8	1			-12.1	1						
4215	-62.0	1			-31.8	1	+120.5	1				
4233	-65.4	1			-13.5	1			-18.0	1	+115.5	1
4236	-66.8	1	+114.7	1					-20.6	1	+92.4	1
4250	-82.2	1							-25.5	1	+96.8	1
4260					-23.9	1	+119.0	1	-22.5	1	+105.6	1
4271					-27.9	1	+116.0	1	-19.0	1		
4289	-73.9	1	+94.0	1	-31.6	1					+108.1	1
4308	-89.5	1							-2.8	1	+106.6	1
4325	-65.9	1	+104.5	1					-9.1	1	+129.1	1
4351	-71.8	1	+105.3	1					-13.8	1		
4481	-75.1	1	+124.0	1					-15.7	1		
4549	-70.9	1	+123.4	1	-32.8	1	+130.5	1				
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Weighted												
mean	-71.71	1	+113.35		-23.72	1	+118.25		-14.70	1	+112.25	
V _a	+ 8.04	1	+ 8.04		-26.88	1	-26.88		-27.22	1	-27.22	
V _d	+ 0.12	1	+ 0.12		-0.06	1	-0.06		-0.04	1	-0.04	
Curv.	- 0.28	1	- 0.28		- 0.28	1	- 0.28		- 0.28	1	- 0.28	
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Radial Velocity	- 63.8	1	+121.2		- 50.9	1	+ 91.0		- 42.0	1	+ 84.8	

MEASURES OF 40 AURIGE *Concluded*

λ	8083				8084							
	Primary		Secondary		Primary		Secondary					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	-14.1	1	+104.7	1	-8.8	1	+92.8	1	...	...	...	...
4045	-14.2	1	+104.3	1	-18.6	1	+110.0	1	...	...	...	...
4063	-0.9	1	+113.6	1	-2.7	1	...	...	...	...	...	...
4077	-19.2	1	+111.9	1	+3.6	1	+117.8	1	...	...	...	...
4143	-14.0	1	...	...	29.3	1	...	...	...	...	...	...
4198	-31.4	1	...	...	-18.0	1	+128.3	1	...	...	...	...
4215	20.0	1	+117.5	1	-5.9	1	+111.5	1	...	...	...	...
4271	-14.5	1	+133.0	1	-12.0	1	+110.0	1	...	...	...	...
4289	-13.6	1	+111.0	1	-30.9	1	+113.5	1	...	...	...	...
4308	-14.3	1	+112.5	1	-20.7	1	+98.4	1	...	...	...	...
4325	...	...	...	...	-2.3	1	...	...	...	...	...	...
4340	...	...	...	...	-7.5	1	...	...	...	...	...	...
4481	...	...	...	...	-5.2	1	-109.5	1	...	...	...	...
4549	-19.7	1	...	...	-8.3	1	...	...	...	...	...	...
4236	...	...	...	...	...	...	...	...	...	...	...	...
Weighted mean	-16.00	1	+114.81	1	-11.54	1	+110.30	1	...	...	...	...
V _a	-27.23	1	-27.23	1	-27.24	1	-27.24	1	...	...	...	...
V _d	-0.15	1	-0.15	1	-0.22	1	-0.22	1	...	...	...	...
Curv.	-0.28	1	-0.28	1	-0.28	1	-0.28	1	...	...	...	...
Radial Velocity	-43.7	1	+87.2	1	-39.3	1	+82.6	1	...	...	...	...

In the majority of the early plates the lines are single, for the shape of the velocity curve is such that plates taken at random stand about one chance in seven of showing the two components far enough apart to be resolved on one-prism spectrograms. The character of the velocity curve was suspected from the first few plates and as soon as the period was approximately determined, a few exposures were made with the slit of the spectrograph narrower than usual in an attempt to see whether the two components could be resolved in the interval, phases twelve to thirty days (cf. curve). This attempt was unsuccessful and so the observations thereafter were confined in general to the narrow limits, phases from two to eleven days.

The problem of determining satisfactory elements presents some difficulties. Ordinarily when two sets of lines are visible on the spectrograms, it is possible to make use of the plates taken near the crossing points of the two curves. Plates were taken at these points and were useful in finding the preliminary elements, but they were not included in the final solution because the shape of the radial velocity curves before and after crossing are very dissimilar. The result is that the final elements rest upon measures of plates where only the two spectra are visible. There can be no doubt that much more determinate elements would result with higher dispersion, but the final elements given are believed to be fairly accurate. This belief is founded not only on the small probable errors, which the least-square solution assigns to the results, but also on the disposition of the velocities where the spectrograms show single lines.

The observations where both components were visible were first grouped into normal places.

NORMAL PLACES

Julian Date	Phase from J. D. 2,420,462	Primary				Secondary				
		Velocity	Weight	(O-C) ₁	(O-C) ₂	Velocity	Weight	(O-C) ₁	(O-C) ₂	
				(O-C) ₁	(O-C) ₂			(O-C) ₁	(O-C) ₂	
1.....	2,420,466·245	4·245	-16·60	.8	+2·52	+1·76	+ 66·1	.4	+4·48	+6·26
2.....	466·696	4·696	-29·10	1·0	+1·43	+0·71	+ 72·5	.5	-3·03	-1·28
3.....	467·214	5·214	-45·60	.8	-0·40	-1·04	+ 91·5	.4	-1·92	-0·22
4.....	467·404	5·404	-52·30	1·2	-1·86	-2·46	+ 94·1	.6	-5·72	-4·04
5.....	467·622	5·622	-53·20	1·2	+2·63	+2·13	+103·4	.6	-2·99	-1·45
6.....	468·011	6·011	-65·20	.6	-3·12	-3·35	+114·0	.3	-0·01	+1·13
7.....	468·166	6·166	-65·20	.8	-2·33	-2·27	+114·0	.4	-0·98	-0·06
8.....	468·418	6·418	-59·00	1·2	+2·82	+3·28	+117·9	.6	+4·21	+4·62
9.....	469·213	7·213	-42·00	1·2	+2·42	+4·12	+ 92·1	.6	-0·37	-1·51
10.....	469·484	7·484	-42·10	1·6	-5·44	-3·48	+ 84·9	.8	+1·90	+0·40
11.....	469·742	7·742	-30·40	0·8	-0·90	+1·22	+ 75·2	.4	+0·92	-0·77
12.....	470·094	8·094	-23·60	1·0	-3·05	+0·85	+ 64·5	.5	+1·14	-0·68

The relation

$$\gamma(m_1 + m_2) = m_2 V_1 + m_1 V_2$$

was transformed by putting $k = m_1/m_2$ and $y = \gamma(1+k)$ so that it becomes

$$y = V_1 + kV_2$$

The twelve normal places for V_1 and V_2 give twelve observation equations to determine y and k . This solution was made and gave

$$k = 0\cdot828 \quad y = +31\cdot56$$

or $\gamma = +17\cdot2$ kilometres.

The normal places and the individual observations, where the two components were not separated, were now plotted on cross-section paper as in the radial velocity curve. The value of ω was assumed to be 180° for the primary curve, (*i.e.*) the one showing the smaller amplitude. The determination of e was made by trial. It is an easy matter with King's graphical method to try any given set of elements and as ω is already assumed known, the only remaining elements that need to be varied are K and e .

The following elements were selected.

$$\begin{aligned}
 P &= 28\cdot28 \text{ days} \\
 T &= \text{J. D. } 2,420,468\cdot20 \\
 e &= 0\cdot56 \\
 \omega_1 &= 180^\circ \\
 \gamma &= + 17\cdot2 \text{ km.} \\
 C_1 &= - 11\cdot49 \text{ km.} \\
 C_2 &= + 52\cdot31 \text{ km.} \\
 K_1 &= 51\cdot41 \text{ km.} \\
 K_2 &= 62\cdot70 \text{ km.}
 \end{aligned}$$

The residuals which result from these elements are given under the heading (O-C) in the table of normal places. In making a least-square solution, all the elements save P were included and the elements of both curves carried at the same time, so that the twelve normal places yield twenty-four observation equations. The results of the fainter component were given half the weight assigned to the primary.

OBSERVATION EQUATIONS

	<i>x</i>	<i>y</i>	<i>z</i>	<i>u</i>	<i>v</i>	<i>w</i>	$-n$	Weight
1.....	1	- .708	0	+1.015	- .508	+ .596	-2.520	.8
2.....	1	- .930	0	+ .912	- .477	+ .695	-1.430	1.0
3.....	1	-1.216	0	+ .496	- .388	+ .725	+ .400	.8
4.....	1	-1.318	0	+ .260	- .336	+ .680	+1.860	1.2
5.....	1	-1.422	0	- .038	- .260	+ .572	-2.630	1.2
6.....	1	-1.544	0	- .452	- .091	+ .219	+3.120	.6
7.....	1	-1.560	0	- .512	- .016	+ .040	+2.330	.8
8.....	1	-1.539	0	- .434	+ .105	- .251	-2.820	1.2
9.....	1	-1.200	0	+ .529	+ .395	- .729	-2.420	1.2
10.....	1	-1.050	0	+ .780	+ .448	- .727	+5.440	1.6
11.....	1	- .910	0	+ .928	+ .482	- .689	+0.900	0.8
12.....	1	- .736	0	+1.009	+ .506	- .611	+3.050	1.0
13.....	1	0	+ .708	-1.238	+ .620	- .727	-4.480	.4
14.....	1	0	+ .930	-1.112	+ .582	- .848	+3.030	.5
15.....	1	0	+1.216	- .605	+ .473	- .885	+1.920	.4
16.....	1	0	+1.318	- .317	+ .409	- .830	+5.720	.6
17.....	1	0	+1.422	+ .046	+ .317	- .698	+2.990	.6
18.....	1	0	+1.544	+ .552	+ .111	- .268	+0.010	.3
19.....	1	0	+1.560	+ .625	+ .020	- .049	+0.980	.4
20.....	1	0	+1.539	+ .529	- .127	+ .306	-4.210	.6
21.....	1	0	+1.200	- .645	- .481	+ .889	+0.370	.6
22.....	1	0	+1.050	- .951	- .547	+ .887	-1.900	.8
23.....	1	0	+0.910	-1.132	- .587	+ .840	-0.920	.4
24.....	1	0	+ .736	-1.231	- .617	+ .746	-1.140	.5



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Where $x = d\gamma$
 $y = dK_1$
 $z = dK_2$
 $u = de$
 $v = 100d\omega$
 $w = \frac{100\mu dT}{(1-e^2)^{\frac{3}{2}}}$

The normal equations are

$$\begin{aligned} 18.300x - 14.362y + 7.180z + 1.881u + 0.091v - 0.034w + 7.222 &= 0 \\ + 17.876y - 0.000z - 3.882u - 0.049v - 0.306w - 5.231 &= 0 \\ + 8.933z - 2.367u - 0.030v - 0.189w + 2.798 &= 0 \\ + 9.607u + 0.978v - 1.485w + 6.571 &= 0 \\ + 3.031v - 4.774w + 9.460 &= 0 \\ + 7.809w - 14.932 &= 0 \end{aligned}$$

Whence $x = -0.293$ or $d\gamma = -0.29$ km.
 $y = -0.030$ $dK_1 = -0.03$ km.
 $z = -0.186$ $dK_2 = -0.19$ km.
 $u = -0.380$ $de = -0.0038$
 $v = -2.808$ $d\omega = -1^\circ.60$
 $w = +0.116$ $dT = +.003$ day

and the final elements with their probable errors become,

$P = 28.28$ days	$\pm .005$ (estimated)
$T = \text{J.D. } 2,420,468.197$	$\pm .088$ day
$e = 0.556$	$\pm .0065$
$\omega_1 = 178^\circ.41$	$\pm 3^\circ.1$
$\omega_2 = 1^\circ.60$	$\pm 3^\circ.1$
$K_1 = 51.38$ km.	± 1.50 km.
$K_2 = 62.51$ km.	± 1.64 km.
$\gamma = +16.91$ km.	± 1.83 km.
$a_1 \sin i = 16,550,000$ km.	
$a_2 \sin i = 20,140,000$ km.	
$m_1 \sin^3 i = 1.354 \odot$	
$m_2 \sin^3 i = 1.113 \odot$	

1960.02

Dominion Observatory

Ottawa

May, 1917.

